Cell Structure

Chapter 4.1-4.3

Biol 1A

California State University, Fresno

Learning Goals

1. Choose the appropriate microscope for a specific application
2. Describe the differences and similarities between prokaryote and eukaryote cells
3. Describe the organelles of eukaryotic cells and identify their function in the cells.
4. Provide examples of structure relating to function in cell types.

All Living Things are Made of Cells

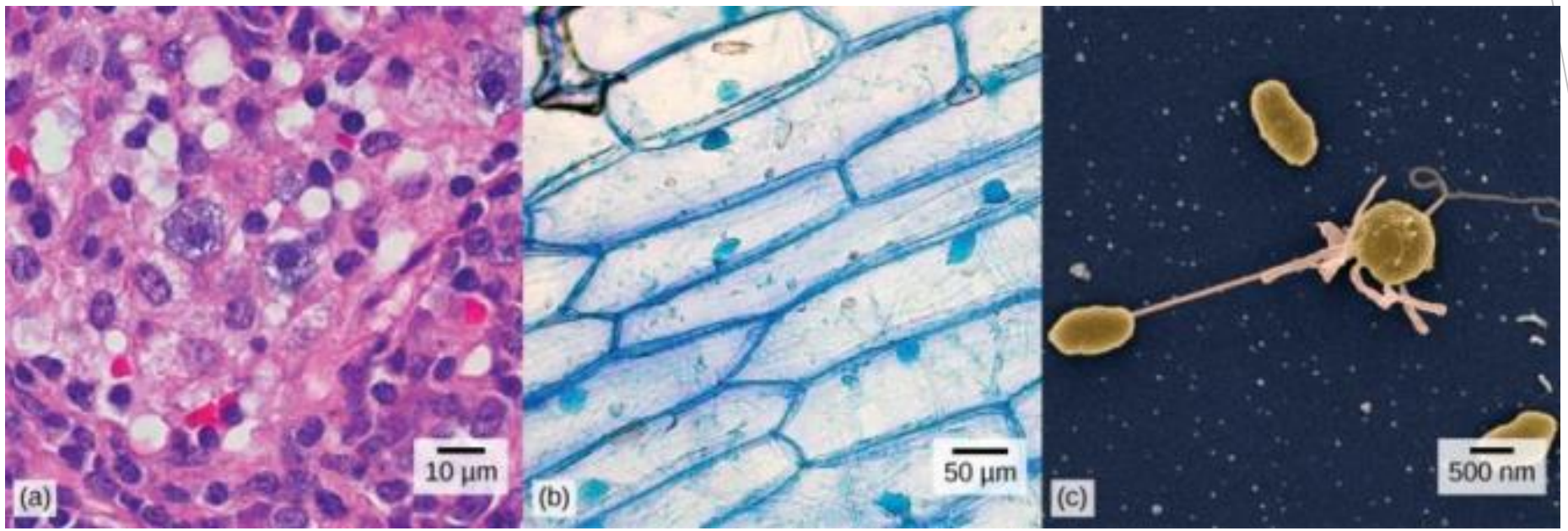


FIGURE 4.1 (a) Nasal sinus cells (viewed with a light microscope), (b) onion cells (viewed with a light microscope), and (c) *Vibrio tasmaniensis* bacterial cells (seen through a scanning electron microscope) are from very different organisms, yet all share certain characteristics of basic cell structure. (credit a: modification of work by Ed Uthman, MD; credit b: modification of work by Umberto Salvagnin; credit c: modification of work by Anthony D'Onofrio, William H. Fowle, Eric J. Stewart, and Kim Lewis of the Lewis Lab at Northeastern University; scale-bar data from Matt Russell)

Cell theory

- In a 1665 publication called *Micrographia*, experimental scientist Robert Hooke coined the term “cell” for the box-like structures he observed when viewing cork tissue through a lens.
- In the 1670s, van Leeuwenhoek discovered bacteria and protozoa. Later advances in lenses, microscope construction, and staining techniques enabled other scientists to see some components inside cells.
- By the late 1830s, botanist Matthias **Schleiden** and zoologist Theodor **Schwann** were studying tissues and proposed the **unified cell theory**:

1) All living organisms are composed of one or more **cells**
2) Cells are the **smallest units of life**
3) New cells come only from pre-existing cells by **cell division**

Types of Cells

- Cells fall into one of two broad categories: **prokaryotic** and **eukaryotic**.

- All cells share four common components:
  1) a **plasma membrane**, an outer covering that separates the cell's interior from its surrounding environment;
  2) **cytoplasm**, consisting of a jelly-like cytosol within the cell in which other cellular components are found;
  3) **DNA**, the genetic material of the cell; and
  4) **ribosomes**, which synthesize proteins.

Prokaryotic Cells

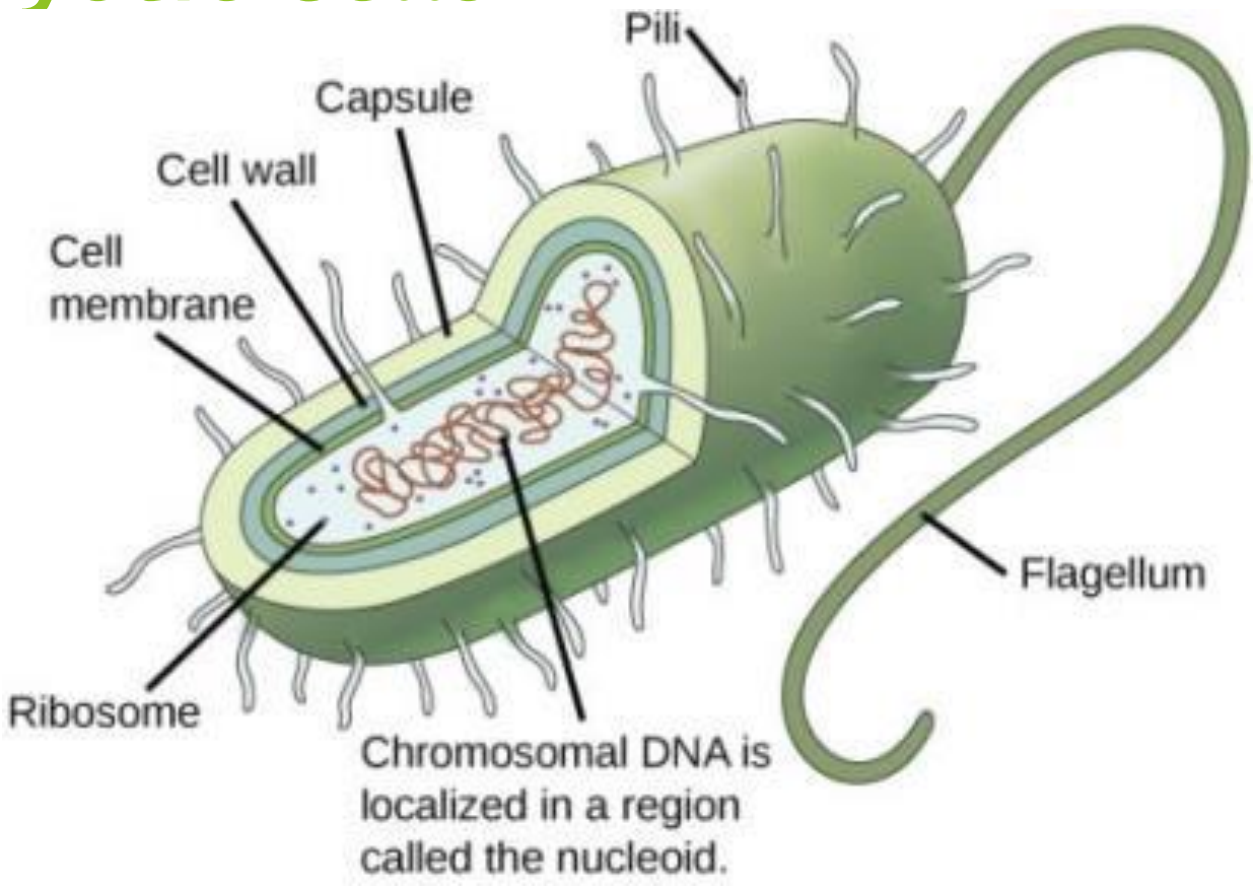


FIGURE 4.5 This figure shows the generalized structure of a prokaryotic cell. All prokaryotes have chromosomal DNA localized in a nucleoid, ribosomes, a cell membrane, and a cell wall. The other structures shown are present in some, but not all, bacteria.

Cell Size

- At 0.1 to 5.0 μm in diameter, prokaryotic cells are significantly smaller than eukaryotic cells, which have diameters ranging from 10 to 100 μm.
- This is not the case in eukaryotic cells, which have developed different structural adaptations to enhance intracellular transport.

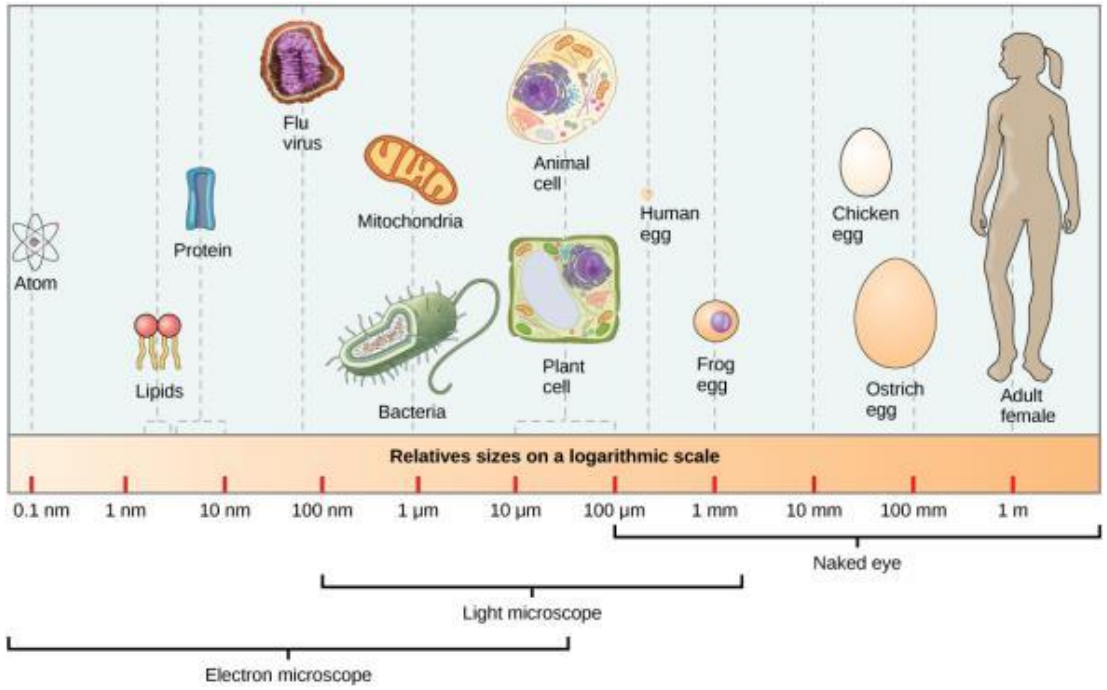
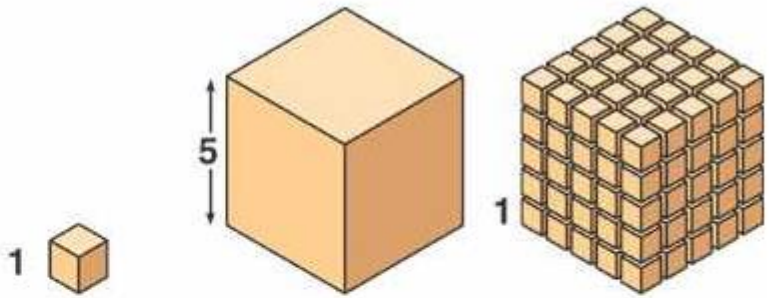


FIGURE 4.6 This figure shows relative sizes of microbes on a logarithmic scale (recall that each unit of increase in a logarithmic scale represents a 10-fold increase in the quantity being measured).

Surface area increases while total volume remains constant



Total surface area (height × width × number of sides × number of boxes)	6	150	750
Total volume (height × width × length × number of boxes)	1	125	125
Surface-to-volume ratio (surface area / volume)	6	1.2	6

The Plasma Membrane

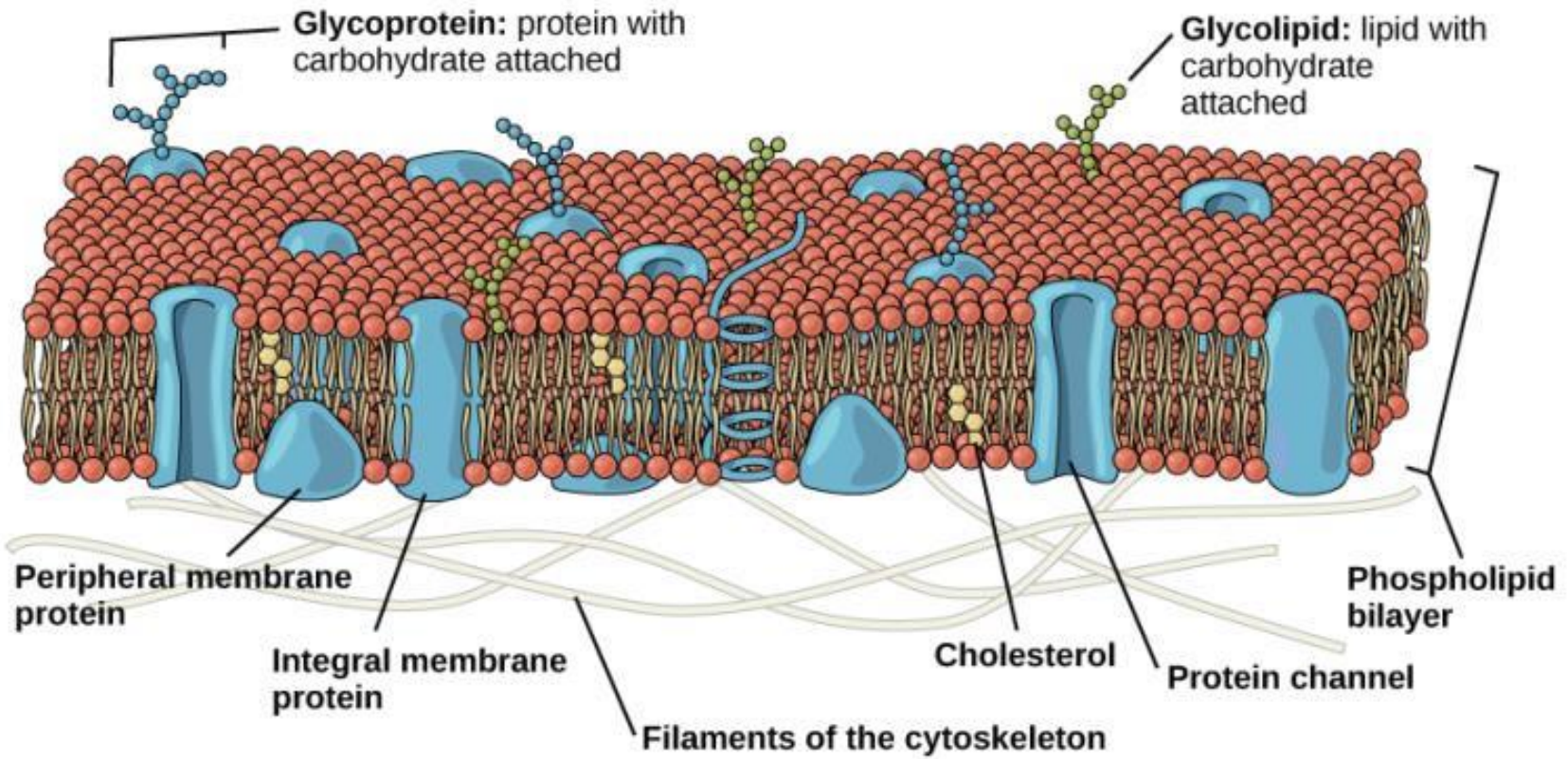
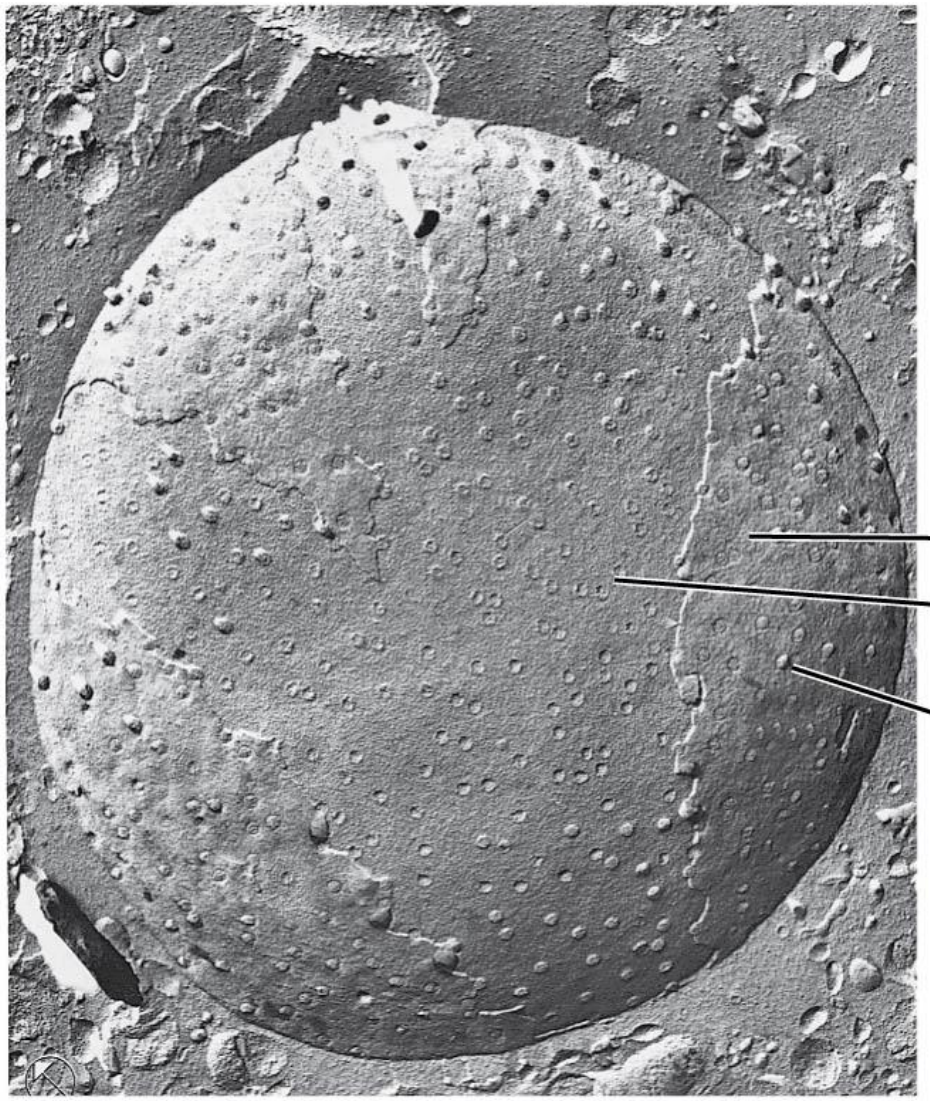


FIGURE 4.9 The eukaryotic plasma membrane is a phospholipid bilayer with proteins and cholesterol embedded in it.

The Cytoplasm (and cytosol)

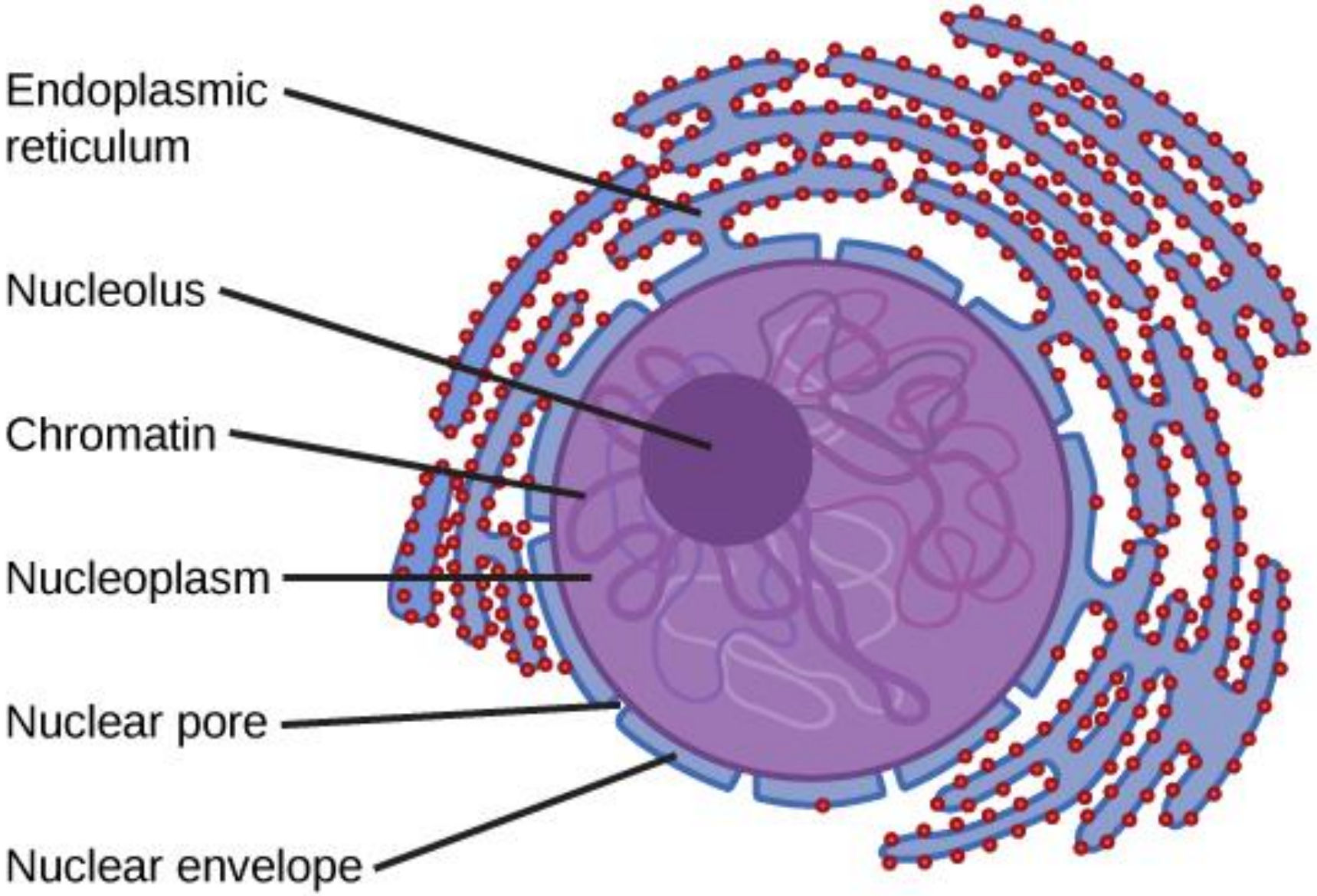
- The **cytoplasm** is the entire region of a cell between the plasma membrane and the nuclear envelope.
- It is made up of organelles suspended in the gel-like **cytosol**, the cytoskeleton, and various chemicals.
- Even though the cytoplasm consists of 70 to 80 percent water, it has a semi-solid consistency, which comes from the proteins within it.

Nucleus

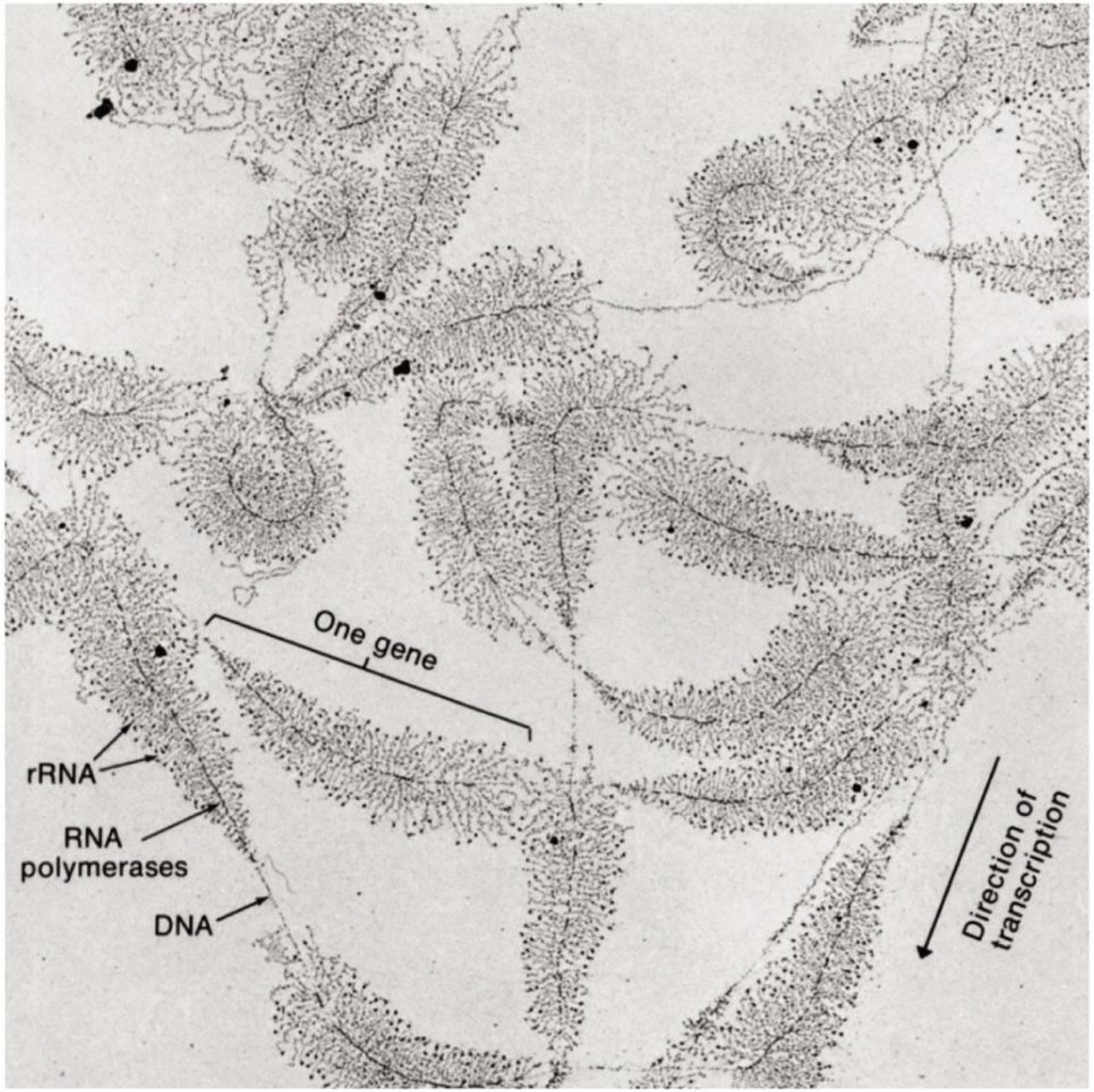


Surface of nuclear envelope (TEM)

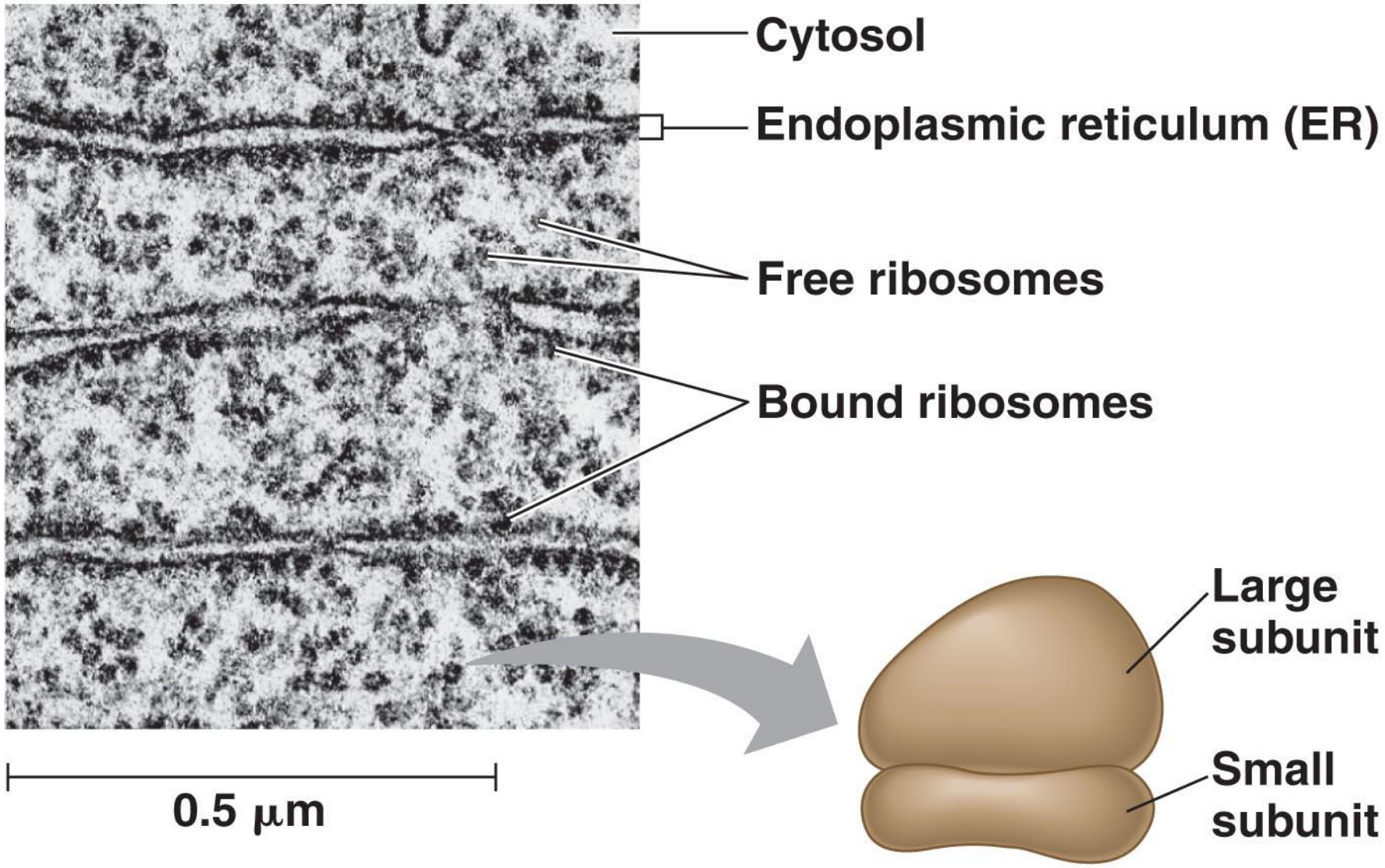
Nucleus


Endoplasmic reticulum
Nucleolus
Chromatin
Nucleoplasm
Nuclear pore
Nuclear envelope

rRNA synthesis in the nucleolus

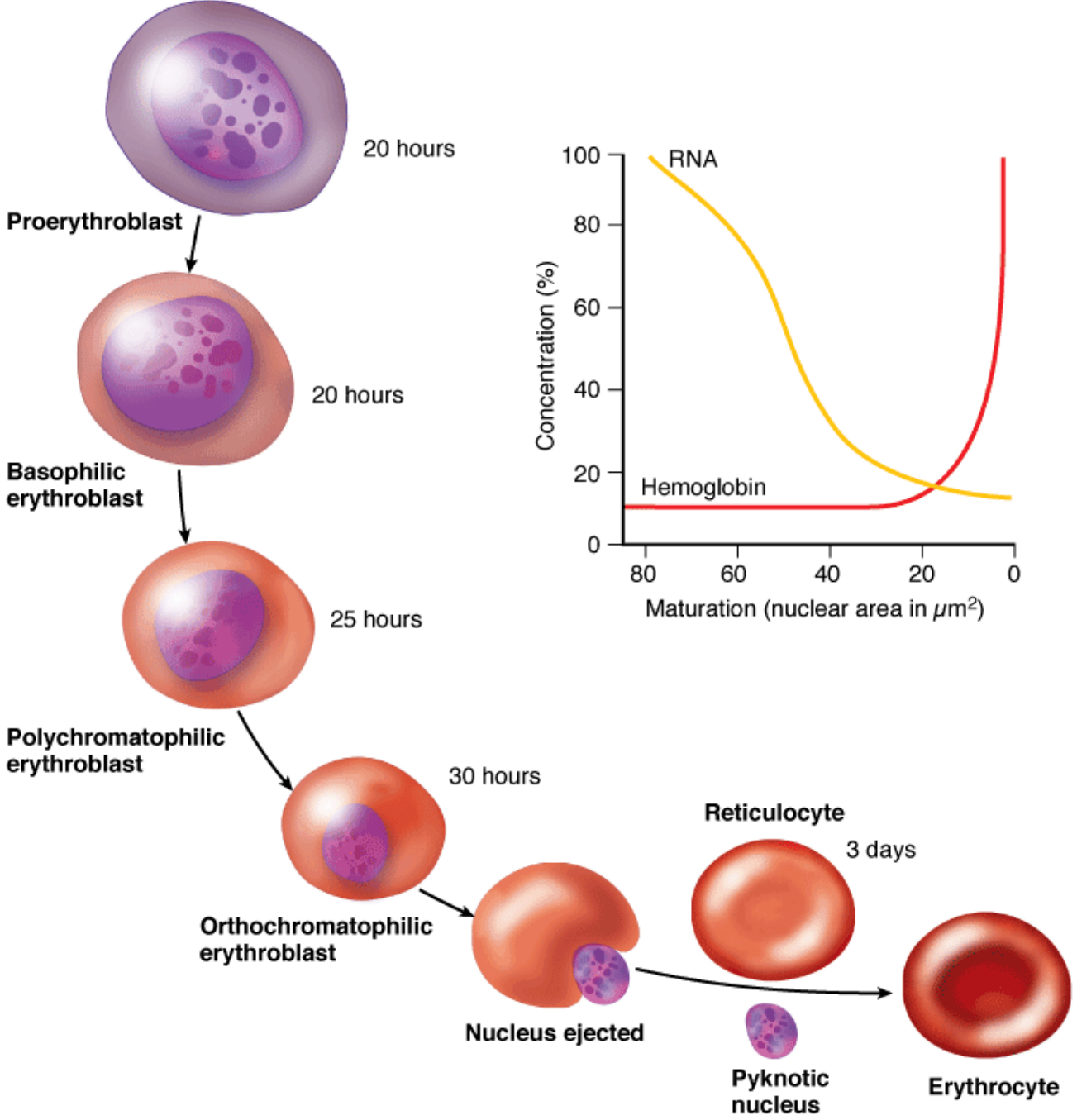


ribosomes

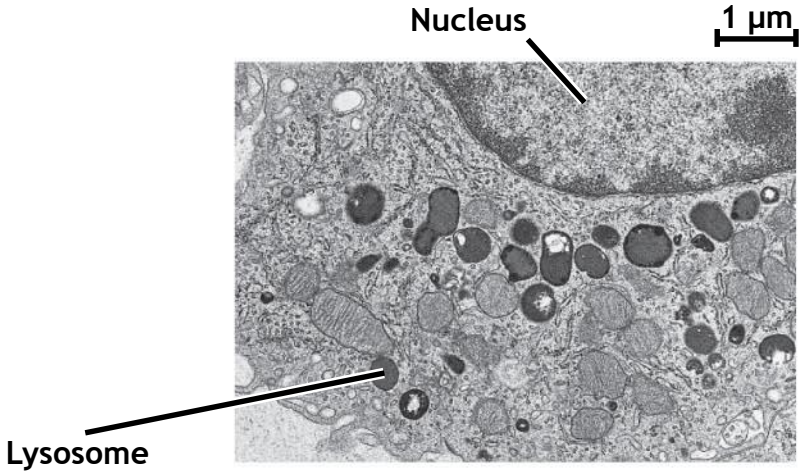


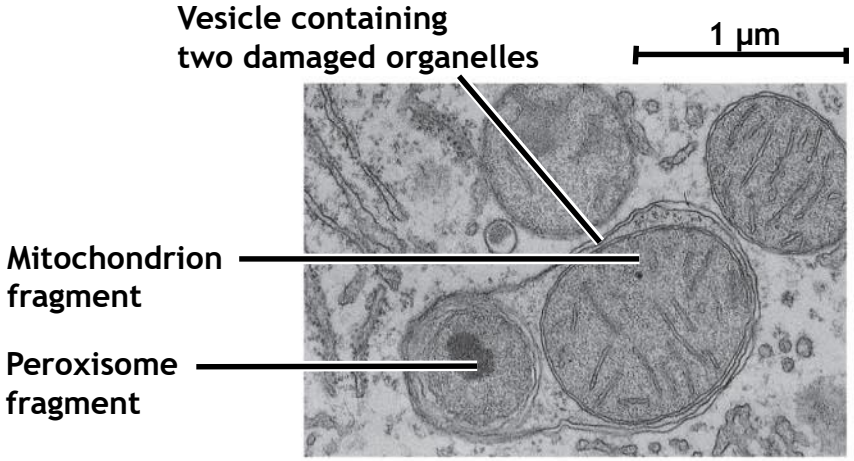
TEM showing ER and ribosomes

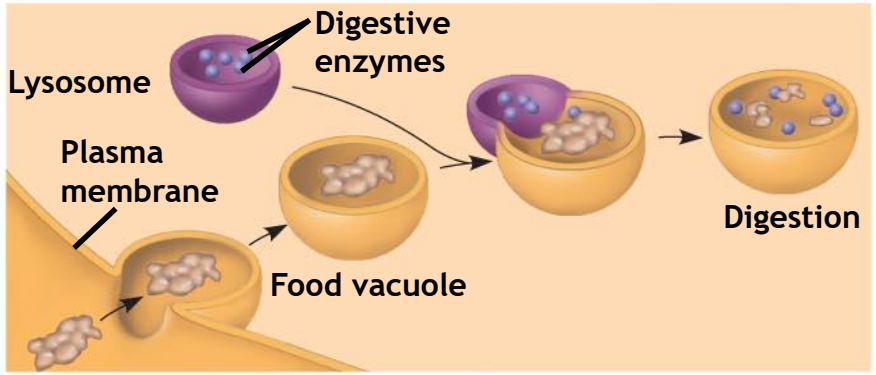
Diagram of a ribosome



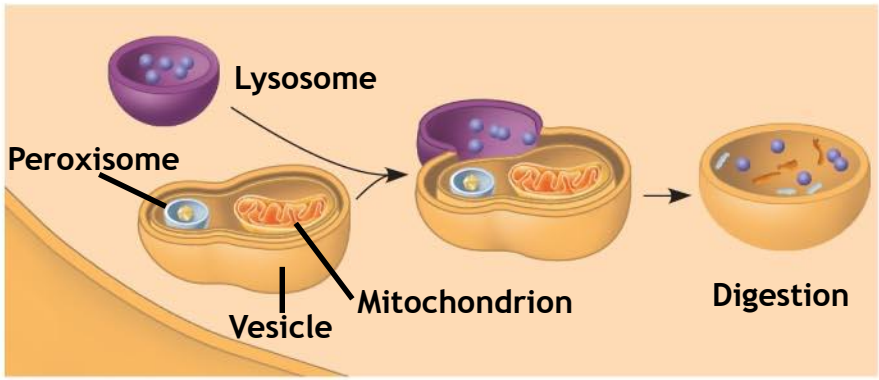
lysosomes – digestive vesicles





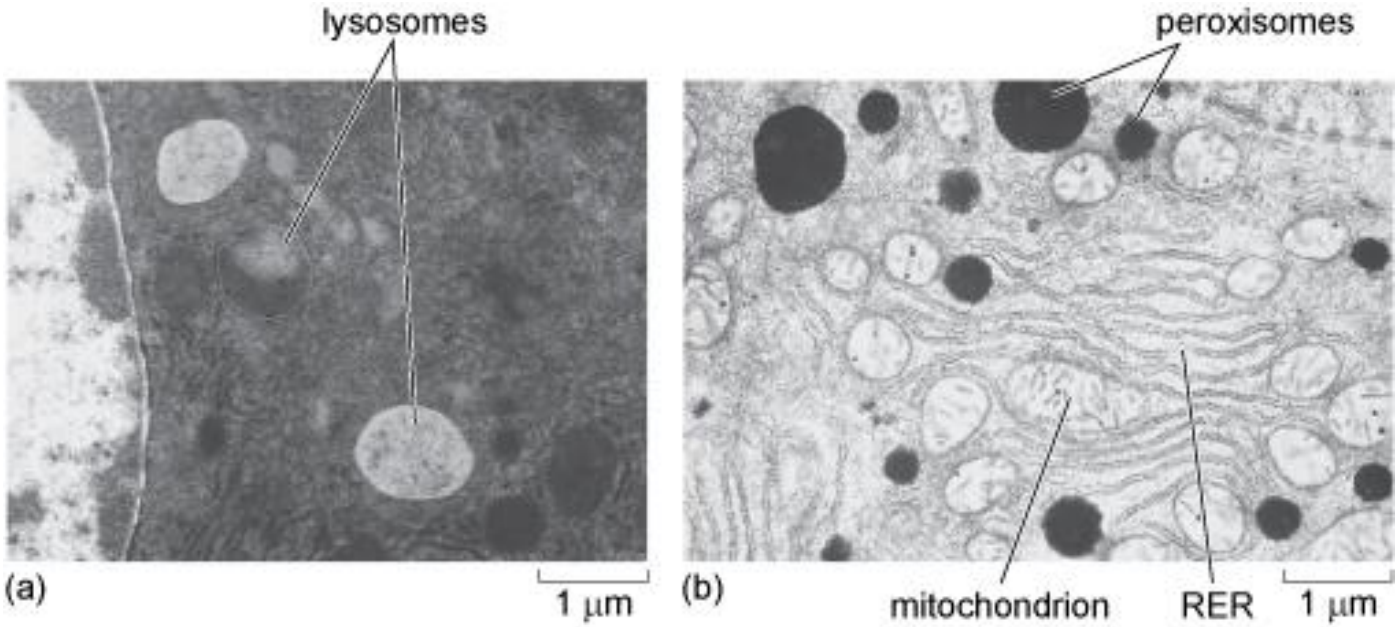


(a) Phagocytosis



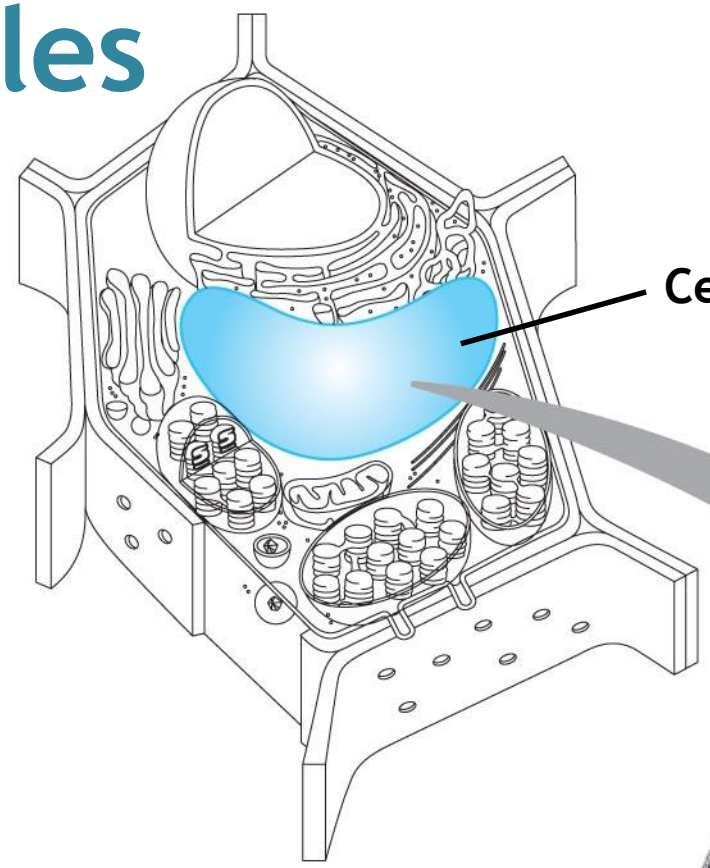
(b) Autophagy

peroxisomes - metabolic vesicles

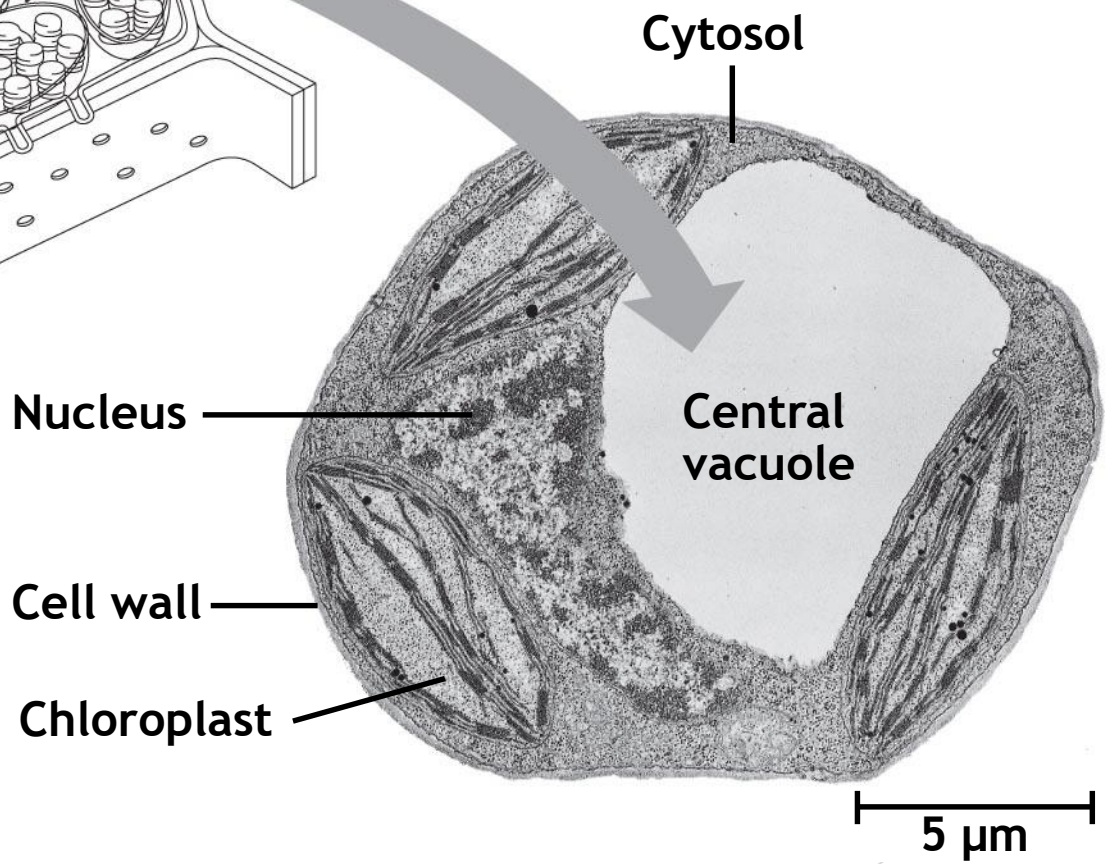


- Vesicle containing metabolic enzymes that can take on different functions
- Contains enzymes that remove hydrogens from molecules and adds them to water producing hydrogen peroxide (hence the name)

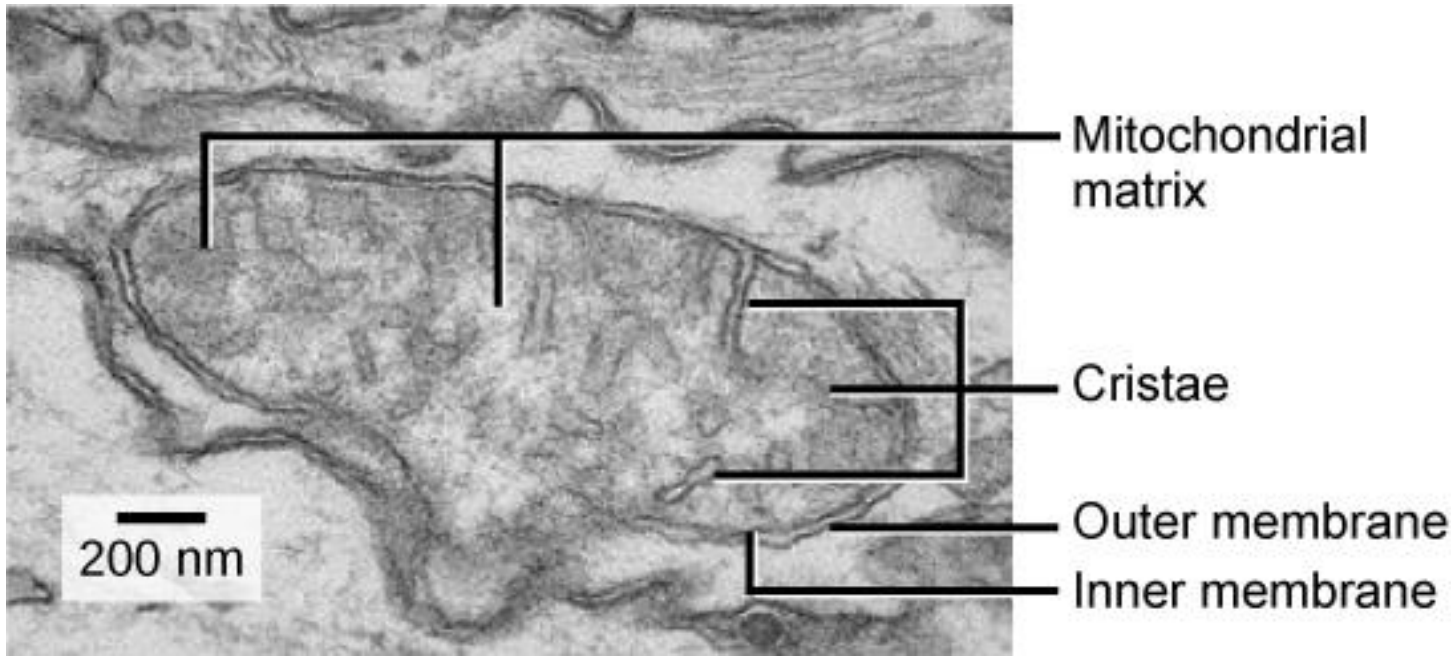
Vacuoles



- in plants/fungi, similar to lysosomes
- plants: central vacuole, stores water, ions (K^+, Cl^-)

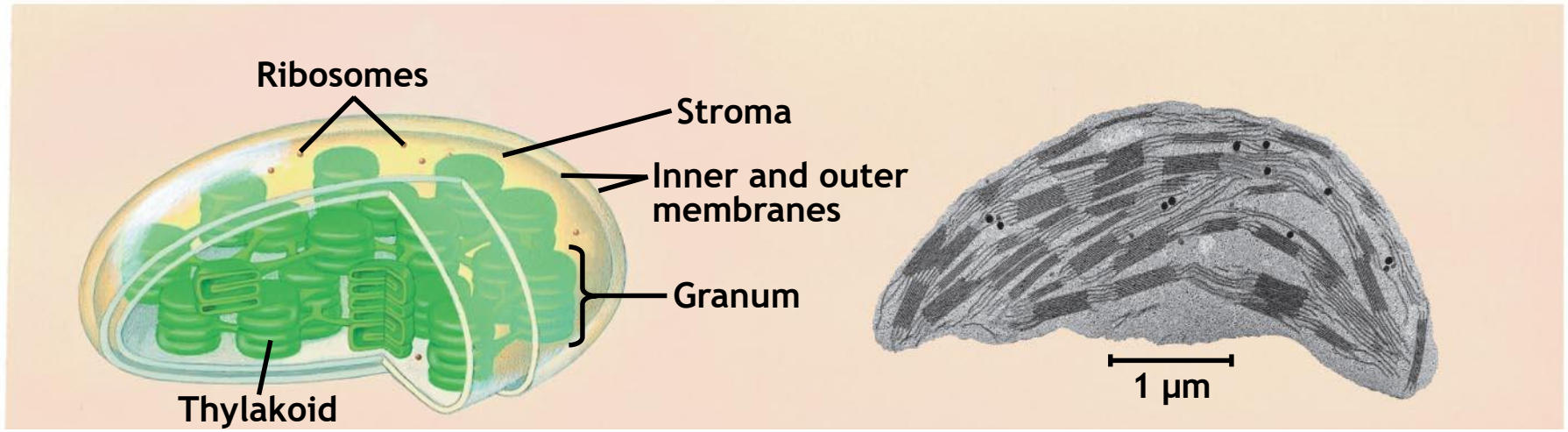


Mitochondria



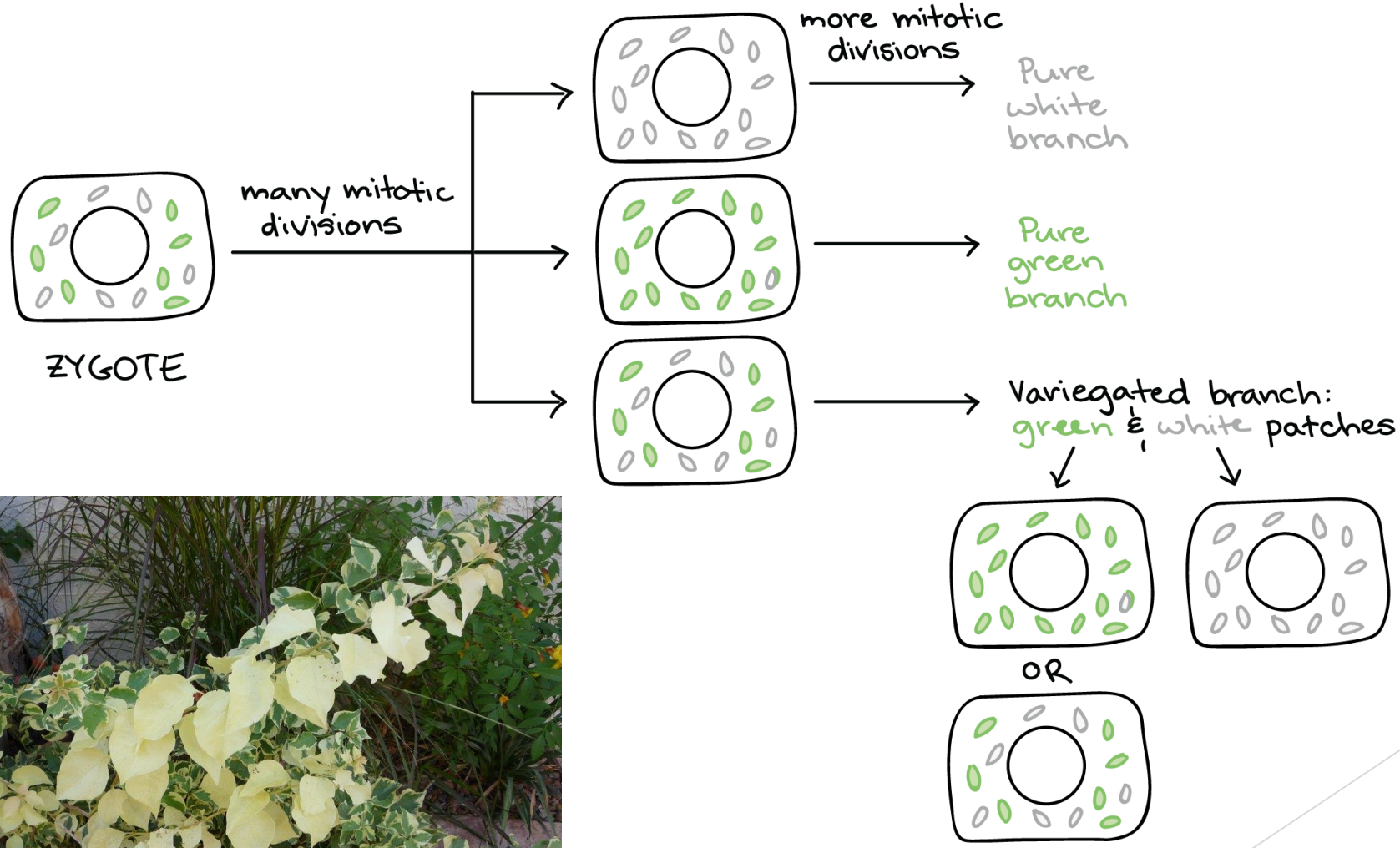
cellular respiration occurs here

Chloroplasts

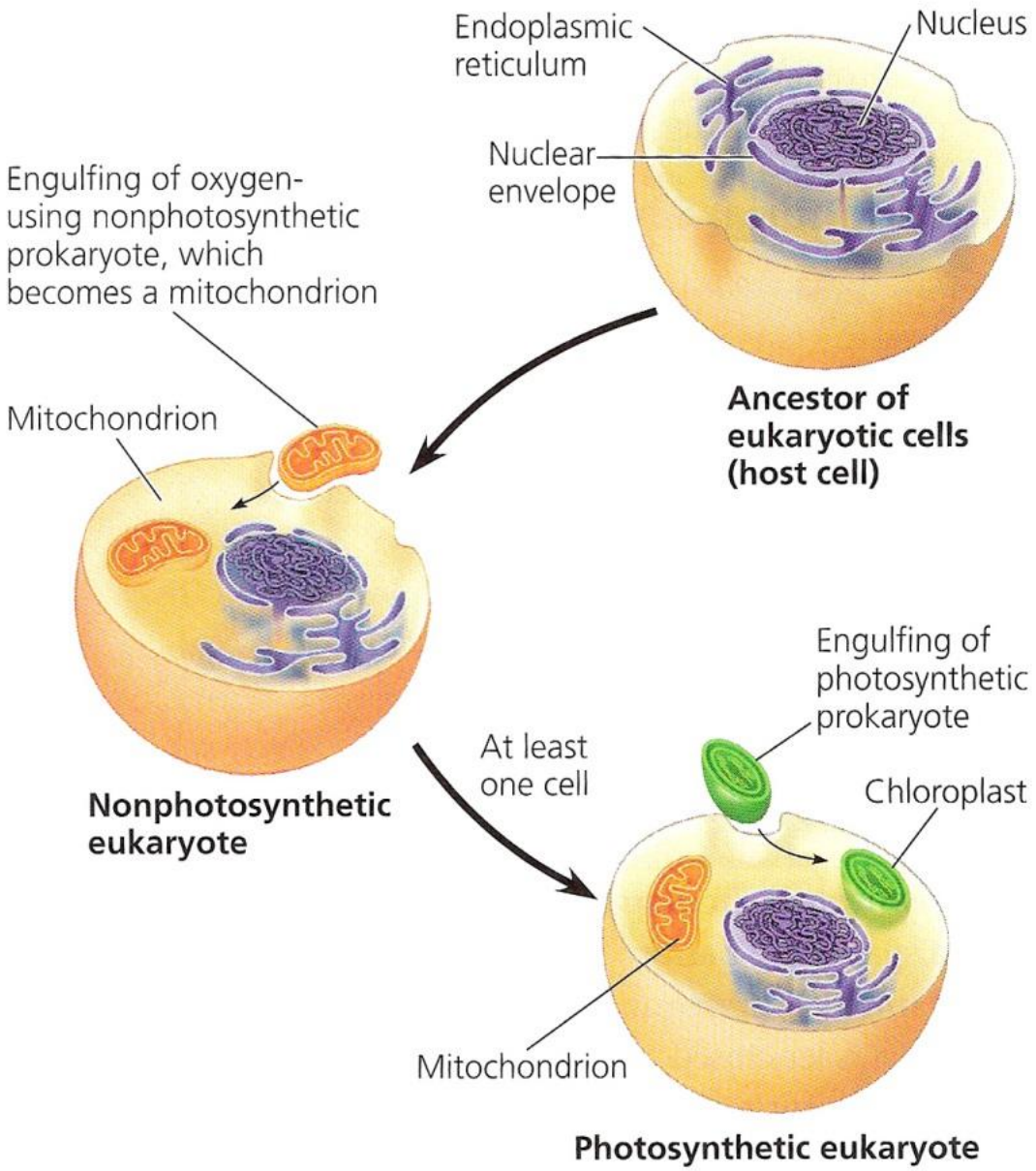


- contain chlorophyll
- photosynthesis
- found in plants, algae

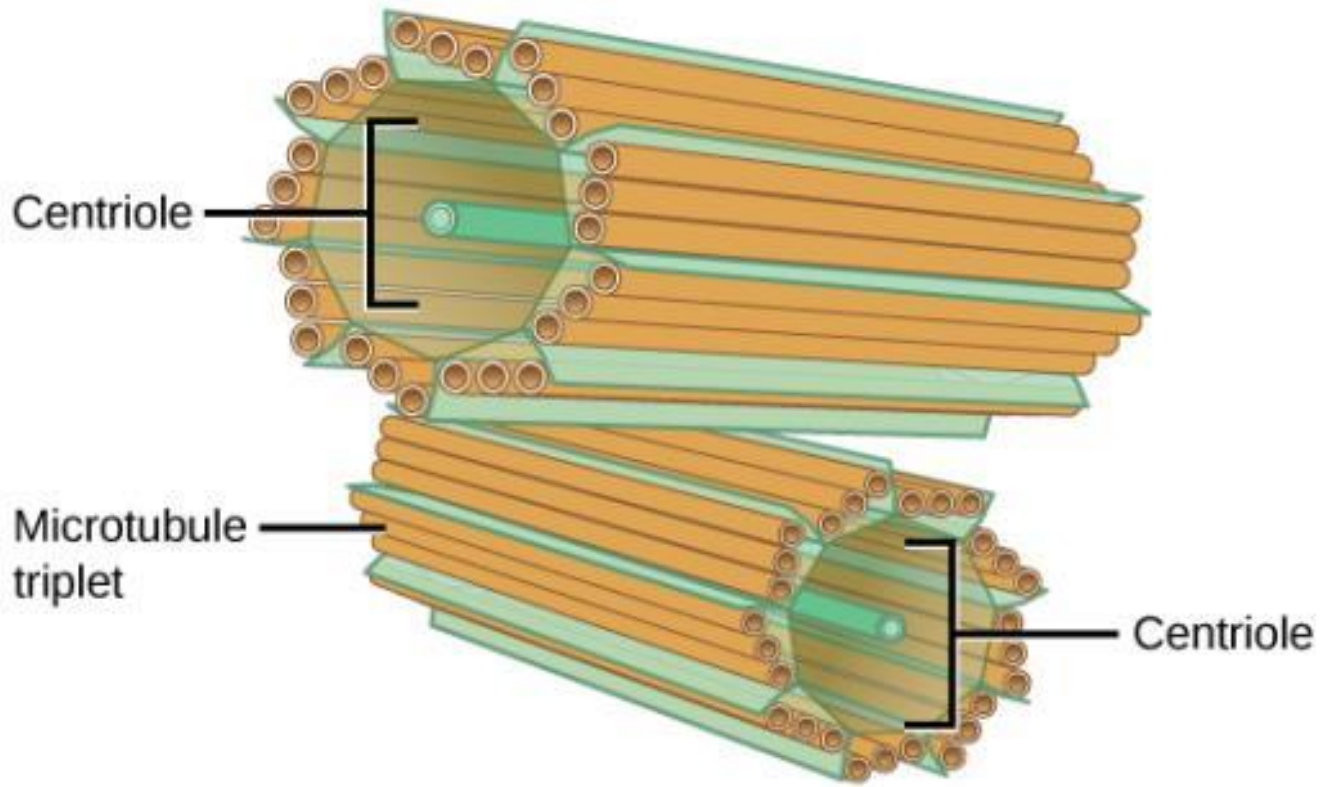
Example: Chloroplast disorder



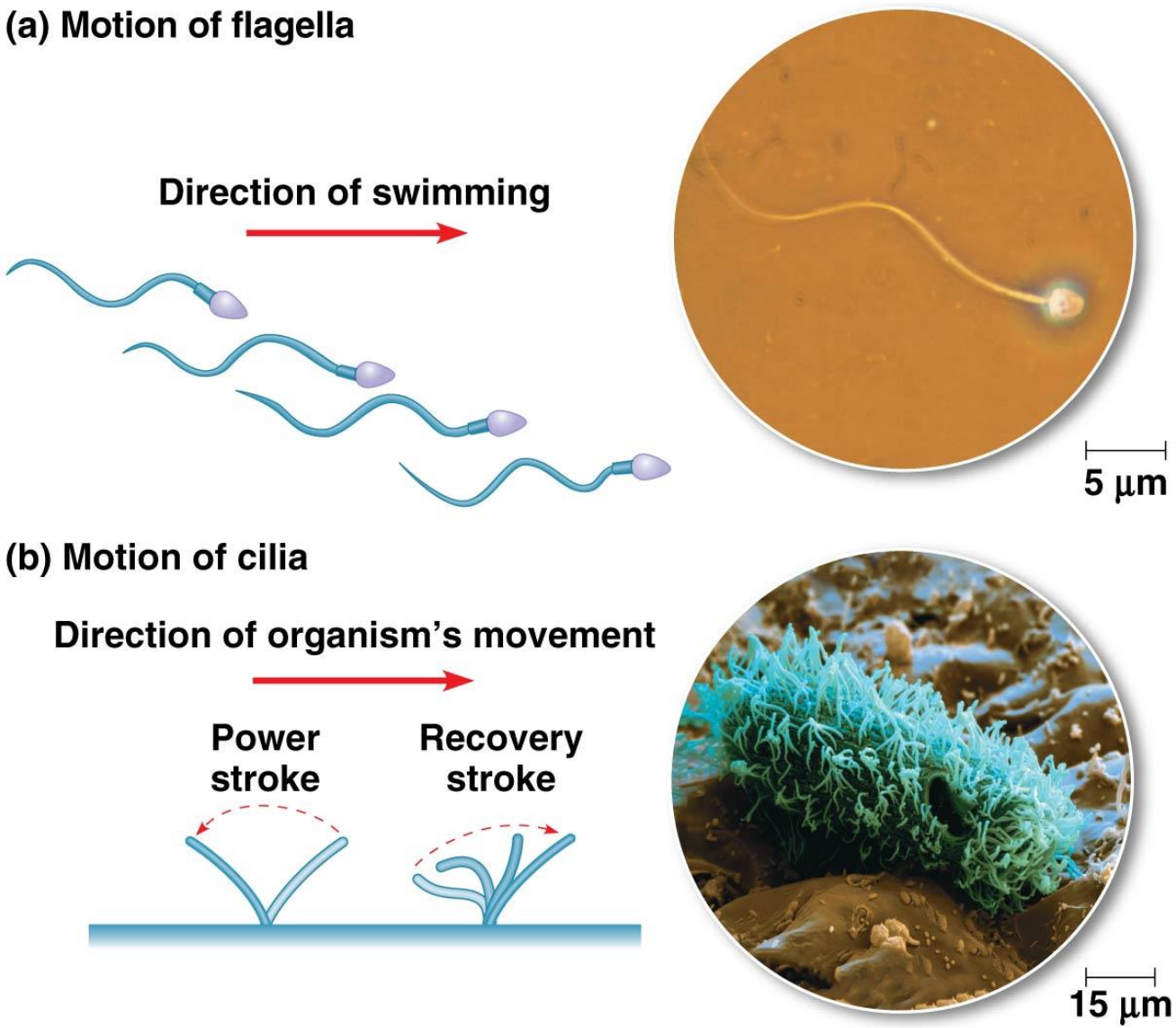
Endosymbiont Theory



Centrosome



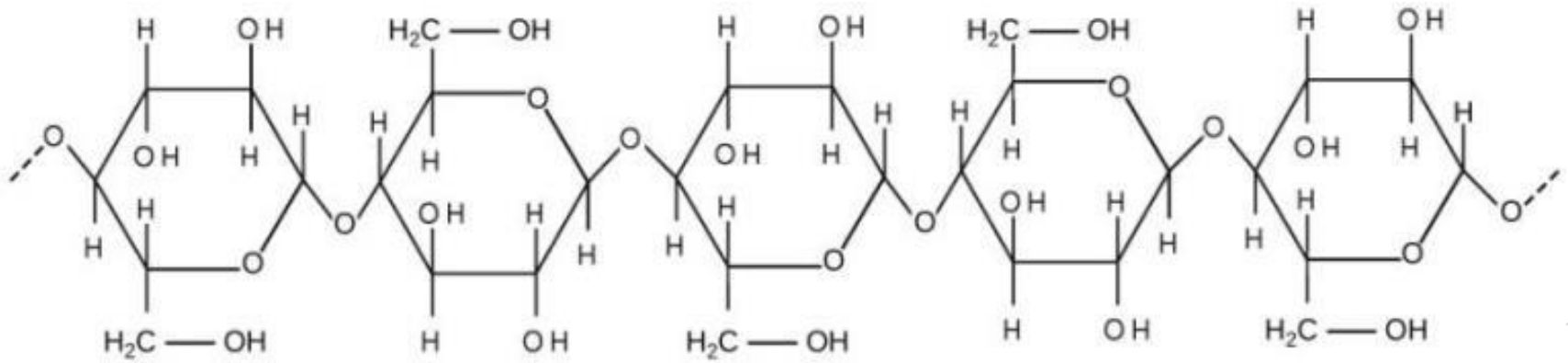
Cilia and Flagella



The Cell Wall

- A plant cells have a structure external to the plasma membrane called the cell wall. The cell wall is a rigid covering that protects the cell, provides structural support, and gives shape to the cell.

- Fungal and protist cells also have cell walls. While the chief component of **prokaryotic** cell walls is **peptidoglycan**, the major organic molecule in the plant cell wall is **cellulose**, a polysaccharide made up of glucose units.



Take Home

- Prokaryotes are simple cells with no membrane-bound organelles. They are unicellular
- Eukaryotes have membrane-bound organelles which each carry out specific functions. These organelles allow cells of a multi-cellular organism to take on a specific task as a part of a greater whole.
- Identify all the organelles discussed in this lecture, their function and how their function relates to the rest of the cell.
- Know the differences between plant and animal cells.